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1. GENERAL BACKGROUND INFORMATION

ACRONYMS AND ABBREVIATIONS USED IN THIS BULLETIN

ACTS	-	Automated Computer Time Service
BIPM	-	Bureau International des Poids et Mesures
Cs	-	Cesium standard
GPS	-	Global Positioning System
IERS	-	International Earth Rotation Service
LORAN	-	Long Range Navigation
MC	-	Master Clock
MJD	-	Modified Julian Date
NVLAP	-	National Voluntary Laboratory Accreditation Program
NIST	-	National Institute of Standards and Technology
NOAA	-	National Oceanic and Atmospheric Administration
SI	-	International System of Units
TA	-	Atomic Time
TAI	-	International Atomic Time
USNO	-	United States Naval Observatory
UTC	-	Coordinated Universal Time

ns	-	nanosecond
μs	-	microsecond
ms	-	millisecond
s	-	second
min	-	minute

2. TIME SCALE INFORMATION

The values listed below are based on data from the IERS, the USNO, and NIST. The UTC(USNO,MC) - UTC(NIST) values are averaged measurements from all available common-view GPS satellites (see bibliography on page 5). **UTC - UTC(NIST) data are on page 3.**

0000 HOURS COORDINATED UNIVERSAL TIME			
DEC 2004	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
2	53341	-488 ms	16 ns
9	53348	-494 ms	14 ns
16	53355	-497 ms	13 ns
23	53362	-503 ms	13 ns
30	53369	-503 ms	10 ns

The master clock pulses used by the WWV, WWVH, and WWVB time-code transmissions are referenced to the UTC(NIST) time scale. Occasionally, 1 s is added to the UTC time scale. This second is called a leap second. Its purpose is to keep the UTC time scale within ±0.9 s of the UT1 astronomical time scale, which changes slightly due to variations in the Earth's rotation.

NOTE: No leap second was added at the end of December 2004.

Positive leap seconds, beginning at 23 h 59 min 60 s UTC and ending at 0 h 0 min 0 s UTC, were inserted in the UTC timescale on 30 June 1972, 1981-1983, 1985, 1992, 1993, 1994, and 1997, and on 31 December 1972-1979, 1987, 1989, 1990,1995, and 1998.

The use of leap seconds ensures that UT1 - UTC will always be held within ±0.9 s. The current value of UT1 - UTC is called the DUT1 correction. DUT1 corrections are broadcast by WWV, WWVH, WWVB, and ACTS and are printed below. These corrections may be added to received UTC time signals in order to obtain UT1.

DUT1 = UT1 - UTC =

+0.0 s beginning 0000 UTC 01 March 2001
-0.1 s beginning 0000 UTC 04 October 2001
-0.2 s beginning 0000 UTC 14 February 2002
-0.3 s beginning 0000 UTC 24 October 2002
-0.4 s beginning 0000 UTC 03 April 2003
-0.5 s beginning 0000 UTC 29 April 2004

The difference between UTC(NIST) from UTC has been within +/–100 ns since July 6, 1994. The table below shows values of UTC - UTC(NIST) as supplied by the BIPM in their Circular T publication for the most recent 310-day period in which data are available. Data are given at ten-day intervals. Five-day interval data are available in Circular T.

0000 Hours Coordinated Universal Time

DATE	MJD	UTC-UTC(NIST) ns
Nov. 30, 2004	53339	4.7
Nov. 20, 2004	53329	2.5
Nov. 10, 2004	53319	2.6
Oct. 31, 2004	53309	3.4
Oct. 21, 2004	53299	1.4
Oct. 11, 2004	53289	3.7
Oct. 01, 2004	53279	3.5
Sep. 21, 2004	53269	4.1
Sep. 11, 2004	53259	4.7
Sep. 01, 2004	53249	2.5
Aug. 22, 2004	53239	0.9
Aug. 12, 2004	53229	-2.5
Aug. 02, 2004	53219	-2.5
Jul. 23, 2004	53209	-4.0
Jul. 13, 2004	53199	-6.0
Jul. 03, 2004	53189	-5.3
Jun. 23, 2004	53179	-6.4
Jun. 13, 2004	53169	-5.2
Jun. 03, 2004	53159	0.2
May 24, 2004	53149	5.4
May 14, 2004	53139	9.9
May 04, 2004	53129	10.5
Apr. 24, 2004	53119	7.5
Apr. 14, 2004	53109	6.9
Apr. 04, 2004	53099	6.7
Mar. 25, 2004	53089	6.3
Mar. 15, 2004	53079	4.1
Mar. 05, 2004	53069	3.2
Feb. 24, 2004	53059	1.2
Feb. 14, 2004	53049	-2.0
Feb. 4, 2004	53039	-4.5

3. PHASE DEVIATIONS FOR WWVB AND LORAN-C

WWVB - The values shown for WWVB are the time differences between the time markers of the UTC(NIST) time scale and the first positive-going zero voltage crossover measured at the transmitting antenna. The uncertainty of the individual measurements is ±0.5 μs. The values listed are for 1300 UTC.

LORAN-C - The values shown for Loran-C represent the daily accumulated phase shift. The phase shift is measured by comparing the output of a Loran receiver to the UTC(NIST) time scale for a period of 24 h. If data were not recorded on a particular day, the symbol (-) is printed. The stations monitored are Baudette, ND (8970-Y) and Fallon, NV (9940). The monitoring is done from the NIST laboratories in Boulder, Colorado.

Note: The values shown for Loran-C are in nanoseconds.

		UTC(NIST)-WWVB (60 kHz)	UTC(NIST) - LORAN PHASE (ns)	
DATE	MJD	ANTENNA PHASE (μs)	LORAN-C (BAUDETTE) (8970)	LORAN-C (FALLON) (9940)
12/01/04	53340	5.72	-100	+111
12/02/04	53341	5.71	-64	-373
12/03/04	53342	5.71	+125	+328
12/04/04	53343	5.71	-33	+58
12/05/04	53344	5.71	-58	-76
12/06/04	53345	5.72	+129	+61
12/07/04	53346	5.73	+3	-273
12/08/04	53347	5.73	-58	+174
12/09/04	53348	5.73	-56	-167
12/10/04	53349	5.72	+4	+101
12/11/04	53350	5.72	+120	-401
12/12/04	53351	5.71	-32	-284
12/13/04	53352	5.72	+175	+184
12/14/04	53353	5.73	+99	+454
12/15/04	53354	5.74	-129	+49
12/16/04	53355	5.73	+97	+48
12/17/04	53356	5.73	-277	-58
12/18/04	53357	5.73	-66	-71
12/19/04	53358	5.73	+311	-52
12/20/04	53359	5.73	-1	+40
12/21/04	53360	5.73	-224	+447
12/22/04	53361	5.73	+292	-392
12/23/04	53362	5.71	+84	-418
12/24/04	53363	5.70	-38	+208
12/25/04	53364	5.71	-62	+208
12/26/04	53365	5.72	-85	-327
12/27/04	53366	5.73	+21	-224
12/28/04	53367	5.74	-210	+332
12/29/04	53368	5.74	-167	-513
12/30/04	53369	5.73	-33	-26
12/31/04	53370	5.72	-129	+269

4. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

OUTAGES OF 5 MINUTES OR MORE							PHASE PERTURBATIONS 2 ms			
Station	DEC 2004	MJD	Began UTC	Ended UTC	Freq.		DEC 2004	MJD	Began UTC	End UTC
WWVB	12-07-04	53346	1242	1329	60 kHz					
WWV										
WWVH										

5. NOTES ON NIST TIME SCALES AND PRIMARY STANDARDS

Primary frequency standards developed and operated by NIST are used to provide accuracy (rate) input to the BIPM. NIST-7 was the U.S. primary standard from 1994 to 1999, when it was replaced by NIST-F1, a cold-atom cesium fountain frequency standard. The uncertainty of NIST-F1 is currently about 1 part in 10^{15}.

The AT1 scale is run in real-time by use of data from an ensemble of cesium standards and hydrogen masers. It is a free-running scale whose frequency is maintained as nearly constant as possible by choosing the optimum weight for each clock that contributes to the computation.

UTC(NIST) is generated as an offset from our real-time scale AT1. It is steered in frequency towards UTC by use of data published by the BIPM in its Circular T. Changes in the steering frequency will be made, if necessary, at 0000 UTC on the first day of the month, and occasionally at mid-month. A change in frequency is limited to no more than $\pm$ 2 ns/day. The frequency of UTC(NIST) is kept as stable as possible at other times.

UTC is generated at the BIPM using a post-processed time-scale algorithm and is not available in real-time. The parameters that we use to generate UTC(NIST) in real-time are therefore based on an extrapolation of UTC from the most recent available data.

6. BIBLIOGRAPHY

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Table 7.1 lists parameters that are used to define UTC(NIST) with respect to our real-time scale AT1. To find the value of UTC(NIST) - AT1 at any time T (expressed as a Modified Julian Day, including a fraction if needed), the appropriate equation to use is the one for which the desired T is greater than or equal to the entry in the T_0 column and less than the entry in the last column. The values of x_{ls}, x, and y for that month are then used in the equation below to find the desired value. The parameters x and y represent the offset in time and in frequency, respectively, between UTC(NIST) and AT1; the parameter x_{ls} is the number of leap seconds applied to both UTC(NIST) and UTC as specified by the IERS. Leap seconds are not applied to AT1.

Table 7.1
$UTC(NIST) - AT1 = x_{ls} + x + y^*(T - T_0)$

Month	x_{ls} (s)	x (ns)	y (ns/d)	T_0 (MJD)	Valid until 0000 on: (MJD)
Feb 05	-32	-274311.15	-39.01*	53402	53430
Jan 05	-32	-273102.15	-39.1	53371	53402*
Dec 04	-32	-272712.15	-39.0	53361	53371
Dec 04	-32	-271891.05	-39.1	53340	53361†
Nov 04	-32	-270718.05	-39.1	53310	53340
Oct 04	-32	-269505.95	-39.1	53279	53310
Sep 04	-32	-268723.95	-39.1	53259	53279
Sep 04	-32	-268330.95	-39.3	53249	53259†
Aug 04	-32	-267898.65	-39.3	53238	53249
Aug 04	-32	-267110.65	-39.4	53218	53238†
Jul 04	-32	-266716.65	-39.4	53208	53218
Jul 04	-32	-265892.4	-39.25	53187	53208†
Jun 04	-32	-265342.9	-39.25	53173	53187
Jun 04	-32	-264722.9	-38.75	53157	53173†
May 04	-32	-264064.15	-38.75	53140	53157
May 04	-32	-263514.65	-39.25	53126	53140†
Apr 04	-32	-263004.4	-39.25	53113	53126
Apr 04	-32	-262334.6	-39.4	53096	53113†
Mar 04	-32	-261783.0	-39.4	53082	53096
Mar 04	-32	-261110.65	-39.55	53065	53082†
Feb 04	-32	-259963.7	-39.55	53036	53065
Jan 04	-32	-259410.0	-39.55	53022	53036
Jan 04	-32	-258738.5	-39.5	53005	53022†

† Rate change in mid-month
†† Rate change one day early
***Provisional value**

7. SPECIAL ANNOUNCEMENTS